

REMARKS

Claims 1-16 and 21-24 are presently pending. Claims 17-20 were canceled by a previous Amendment. Claims 1-7, 14-16 and 22-24 have been withdrawn from consideration. Claims 8-13 and 21 have been rejected. No claims have been allowed. Claims 1-7 have been canceled. Claims 8 and 10-13 have been amended. New claims 25-31 have been added.

I. Priority Claim under 35 U.S.C. § 120

The Office Action Summary states, "Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f)." Applicants respectfully submit that no claim for foreign priority has been made in the instant case. Rather, a claim for priority was properly made under 35 U.S.C. § 120 to co-pending U.S. Patent Application No. 10/224,291.

Appropriate correction is respectfully requested.

II. Withdrawn Claims

Claims 1-7, 14-16 and 22-24 have been withdrawn from further consideration as being drawn to non-elected groups. Applicants expressly reserve the right to pursue these withdrawn claims in a future continuation or divisional application. Applicants note that claims 14-16 and 22-24 all depend directly or indirectly from independent claim 13, such that these withdrawn claims should be reinstated if claim 13 becomes allowed. Claims 1-7 have been canceled in favor of new claims 28-31. Although it is thought that these new claims might be similarly withdrawn, Applicants also note that these new claims have been written to depend directly or indirectly from independent claim 8, such that these claims should be allowed if claim 8 becomes allowed.

III. Claim Objections

Claim 12 is objected to due to informalities. Appropriate amendments to claim 12 have been made, and it is respectfully submitted that the objection has been obviated thereby.

Claim 21 is objected to as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicants respectfully traverse. Claim 21 depends directly from independent claim 13 and recites, "wherein said support coating has been *fully cured* prior to any reflow of any of said plurality of solder bumps." (emphasis added). Claim 13 contains no such restriction. Rather, claim 13 states, "wherein said support coating is *sufficiently rigid* such that it is suitable for significantly constraining portions of the solder bumps near the bump to die interfaces during a subsequent reflow of said plurality of solder bumps." (emphasis added). Since it is possible for a support coating to be "sufficiently rigid" without being "fully cured," dependent claim 21 does further limit the subject matter of claim 13. Accordingly, withdrawal of the pending objection is respectfully requested.

IV. Claim Rejections under 35 U.S.C. § 103

Claims 8-12 and 21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Buchwalter alone. In particular, the Office Action states, "As to claims 10-11 . . . it would have been obvious . . . to construct the support coating having a range of height relative to the bumps . . . because applicant has not established any criticality for the specific range." Applicants respectfully traverse these § 103 rejections.

As an initial matter, Applicants note that significant portions of the present written description and figures are devoted toward the importance of providing a support coating having a specific height range with respect to the solder bumps. In particular, paragraphs 0039 through 0041 and FIGS. 5A through 7B of the application as originally filed directly address the issue of specific height ranges for the support coating. These passages and

figures also disclose the importance of such height ranges and the undesirability of support coatings having heights outside of these ranges, such as below 20 percent or above 70 percent of the solder bump height. Accordingly, it is respectfully submitted that the Applicants *have* established sufficient criticality for the specific heights and height ranges claimed.

Contrary to that which is disclosed in the present application, Buchwalter never teaches or suggests a support coating having a height of 70 percent or less of its solder bump height. In fact, Buchwalter teaches only of polymeric underfill layers having heights *greater* than 70 percent of its solder bump height. While the support layers claimed in the present invention might be used as underfill layers, it has been specifically expressed that such an application is not required. In both of its primary embodiments, Buchwalter teaches a “bilayer wafer level underfill,” whereby two separate polymeric layers are formed on a surface of a semiconductor wafer in such a way that its solder bumps are *entirely covered* (Buchwalter, paragraphs 0013-0018; FIGS. 1F and 2D). Thus, the combined height of the two polymeric underfill layers is greater than 100% of the solder bump heights in either embodiment. In Buchwalter’s first embodiment of FIGS. 1A-1H, underfill layer 14 is always at a height of at least 100 percent of the solder bump height. In its alternative embodiment of FIGS. 2A-2D, underfill layer 14 starts out as completely covering every solder bump (i.e., a height greater than 100 percent of the solder bump height), and is “then thinned . . . to expose a top surface of every bump” (Buchwalter, page 4, col. 1, lines 3-10). The second layer is then applied to cover every bump, such that the combined height of the two layers is greater than 100 percent of the height of the solder bumps (Buchwalter, page 4, col. 1, lines 10-12).

Although this results in a first polymeric layer having a height that is slightly less than 100 percent of the height of the solder bumps, this height is not reduced significantly, particularly with respect to the context of the present claims. Buchwalter expressly provides, “the first polymeric material [underfill layer] has a final thickness of from 25 to about 100

microns" (Buchwalter, end of paragraph 0038). Buchwalter also expressly provides, "the second polymeric material has a thickness of from about 1 to about 10 micron" (Buchwalter, end of paragraph 0044). While it should be presumed that variances in these ranges would ordinarily be proportional, even a worst-case scenario for all variables results in a height for underfill layer 14 that is greater than 70 percent of the height of the solder bumps. At worst, the combined height of the first and second underfill layers is exactly 100 percent of the bump height (rather than greater), the thickness of the first layer is only 25 microns (rather than greater), and the thickness of the second layer is a full 10 microns (rather than less). In determining relative heights, $[25/(25+10)]/1.00$ results in a height for the first layer that is at worst 71.4 percent of the solder ball height. Applicants respectfully submit, however, that given the entire teaching of Buchwalter, it is desirable for this first layer height to be substantially greater than 71.4 percent of its solder ball height.

In addition, any suggestion that it would be obvious to lower the height of the underfill layer of Buchwalter would fly in the face of that which is taught by the reference. A prior art reference must be considered in its entirety, including portions that would lead away from the claimed invention. MPEP § 2141.02. Buchwalter teaches of microelectronic interconnect structures having underfill layers that are fully applied at the wafer level only, such that *only a surface* of a solder bump is to be exposed for bonding purposes. In both of its embodiments, Buchwalter teaches that its solder bumps are fully covered by its pre-applied underfill layers, and that the top surfaces of its solder bumps do not even become exposed until the bonding process is underway. As such, "optimization and experimentation with a specific range for the height of the support coating relative to the bumps" (as stated in the Office Action) is inapplicable to Buchwalter. Further, the second pre-applied underfill layer in Buchwalter is intended only to be a thin and dispersible adhesive layer, such that there is no motivation or incentive to increase the thickness of this layer. Thus, it would not

be obvious to modify Buchwalter to specify a support coating height that is at about or less than 70 percent of the height of the solder bumps. Because each of the pending claims requires that the "the height of said support coating is from about 20 percent to about 70 percent of the pre-reflow height of said solder bumps," all claims are patentable over Buchwalter for at least this reason.

Furthermore, additional limitations have been added to independent claim 8 to further distinguish over the prior art. Such additional limitations include, "mid-level wetting angles [] formed at mid-level junctions where the upper surface of said support coating meets said solder bumps," and "when the solder bumps are reflowed . . . the resulting mid-level wetting angles remain sufficiently high such that said mid-level junctions do not become the primary location for solder joint failure." Support for such added limitations can be found at, for example, paragraphs 0039 through 0041 and FIGS. 5A through 7B (reference character 135) of the specification as filed. It is respectfully submitted that Buchwalter does not disclose such mid-level wetting angles, and that any mid-level wetting angles that might be inherent to Buchwalter would then inherently be a primary location for solder joint failure. As noted above, Buchwalter provides a first polymeric layer having a height that is at least 71.4 percent of the height of its solder bumps, and likely much higher. As illustrated in FIG. 7B (reference character 335) and described at paragraph 0040 of the specification as filed, however, such a relatively high support layer results in a mid-level angle that becomes increasingly acute, to the point of being a primary location for solder joint failure. Not only does Buchwalter not disclose any motivation to optimize such a mid-level wetting angle, it does not even disclose such a wetting angle in the first instance. Accordingly, claim 8 is patentable over Buchwalter for at least this additional reason. Because claims 9-12 and 25-31 all depend from claim 8, these claims are all patentable over Buchwalter for at least the same reasons as for claim 8.

For at least the foregoing reasons, it is respectfully submitted that none of the pending claims are rendered as obvious by Buchwalter. Accordingly, Applicants respectfully request that the pending obviousness rejections be withdrawn.

V. Claim Rejection under 35 U.S.C. § 102

Claim 13 stands rejected under 35 U.S.C. § 102(e) as being anticipated by Buchwalter et al. (2002/0109228 A1) ("Buchwalter"). Applicants respectfully submit that this § 102(e) rejection has been overcome through the amendment made to claim 13.

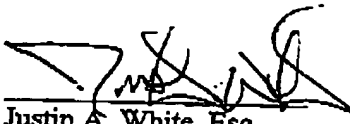
In order to anticipate a claim, a reference must teach every element of that claim. As amended, claim 13 recites, "wherein the height of said support coating is from about 20 percent to about 70 percent of the pre-reflow height of said solder bumps." Because Buchwalter does not state a range for the height of its coating as being between 20 to 70 percent of the pre-reflow height of its solder bumps, as noted in the Office Action, Buchwalter does not anticipate claim 13 as amended. Accordingly, the pending anticipatory rejection has been overcome. Furthermore, claim 13 as amended is non-obvious in view of Buchwalter for at least the same reasons as those given above with respect to the height of the support coating in Section IV. Because claims 14-16 and 21-24 all depend from claim 13, these claims are all patentable over Buchwalter for at least the same reasons as those for claim 13.

CONCLUSION

Applicants respectfully submit that all claims are in proper form and condition for patentability, and thus request a Notification of Allowance to that effect. It is believed that no fees are due at this time. If any fees are due in connection with this Response to Office Action or for this application in general, however, then the Commissioner is hereby authorized to charge such fees to Deposit Account No. 50-0388, referencing Docket No. NSC1P131X3. If there are any questions or issues remaining, the Examiner is respectfully requested to contact the undersigned attorney at the telephone number listed below.

Respectfully Submitted,
BEYER WEAVER & THOMAS, LLP

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Justin A. White, Esq.
Reg. No. 48,883

P.O. Box 70250
Oakland, CA 94612-0250
(650) 961-8300

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